ADVERTISEMENT CALL VARIATION IN THE ARIZONA TREE FROG, *HYLA WRIGHTORUM* TAYLOR, 1938

Brian K. Sullivan[1]

ABSTRACT.—Advertisement call variation and male mating success was investigated in a population of the Arizona tree frog, *Hyla wrightorum*, from central Arizona. Dominant frequency of advertisement calls was significantly correlated (negatively) with male snout-vent length. Males found mating were not significantly larger than nonmating males, nor was there a significant correlation between sizes of males and females found in amplexus. These results are discussed in relation to Renaud's (1977) work with *H. wrightorum* and in light of recent work with anurans in general.

The Arizona tree frog (*Hyla wrightorum*) is primarily restricted to the Petran Montane Conifer Forest Biome (Brown and Lowe 1980) along the Mogollon Rim in central Arizona and extreme west central New Mexico, and in the Huachuca Mountains of southern Arizona (Stebbins 1966, Renaud 1977). Other than discussions of taxonomy, to date little has been published concerning this anuran. In his description Taylor (1938) placed *H. wrightorum* in the *H. eximia* species group; subsequently a number of authors have considered *H. wrightorum* as a subspecies of *H. regilla* (Jameson et al. 1966, Jameson and Richmond 1971) or as conspecific with *H. eximia* (Duellman 1970). However, Renaud (1977) documented that *H. eximia*, *H. regilla*, and *H. wrightorum* are distinct in their morphology (primarily size) and advertisement calls, and in light of their allopatric distributions warrant recognition as full species. Unfortunately Renaud's work remains unpublished and, hence, largely overlooked.

Here I present an analysis of advertisement call variation in a population of *H. wrightorum* from central Arizona. I compare my results with those of Renaud (1977) and hope to draw attention to his valuable work. I also examine the relationship between male size and mating success and test the hypothesis that advertisement call parameters (frequency, pulse rate, and duration) are predictably related to male snout-vent length.

MATERIALS AND METHODS

Breeding aggregations of *H. wrightorum* were observed near the towns of Pine and Strawberry along state route 87, Gila County, Arizona, on the night of 15 July 1984. A third population was observed breeding at Baker Lake near the intersection of forest route 300 and state route 87, Coconino County, Arizona, on the night of 21 July 1984. Calling males were recorded in the field using a Uher Recorder (4000 IC) and a Shure Unidyne IV (548) microphone. Immediately after recording a call, the cloacal temperature of the male was measured with a Schultheis Quick Recording Thermometer. Water and air temperatures were recorded at the calling site as well. All recorded males were collected and toe-clipped for permanent identification. A sample of amplexing pairs was collected at Baker Lake to test the prediction that large males were disproportionately successful in mating (Gatz 1981, Forester and Czarnowsky, 1985).

Calls were analyzed with a Kay 6061 B Sonagraph. Dominant frequency of advertisement calls was measured to the nearest 100 Hz from a section taken at call midpoint (Fig. 1). It is important to note that in *H. wrightorum* the advertisement call is somewhat frequency modulated, increasing about 400 Hz from the beginning to the end of a call. Rate of amplitude modulation was determined by counting the number of pulses in a 0.15-second portion of a wide-band (filter = 300 Hz) audio-spectrogram of three calls for each male, and averaged to yield a mean pulse rate. Similarly, call durations were measured in seconds directly from audio-spectrograms for three calls of each frog, and a mean duration was subsequently calculated.
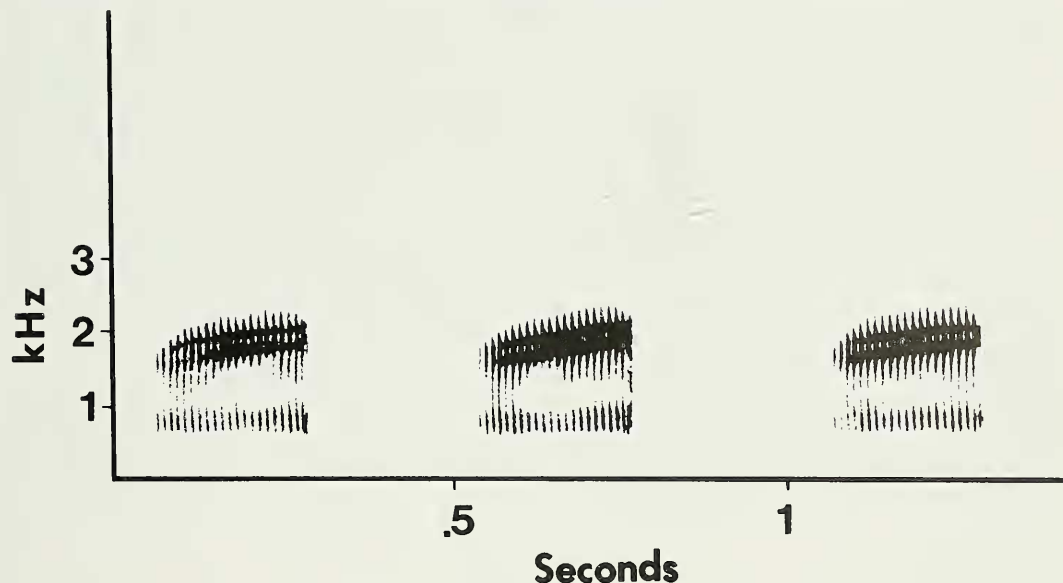
Fig. 1. Audio-spectrogram (filter = 300 Hz) of *Hyla wrightorum* advertisement call. Body temperature = 18 C, snout-vent length = 41 mm.

Table 1. Mean (x̄), standard deviation (SD) and extremes for advertisement call parameters, and snout-vent length of *Hyla wrightorum* from Baker Lake, Arizona (N = 20 for both samples).

	Present study			Renaud (1977)		
	x̄	SD	Extremes	x̄	SD	Extremes
Snout-vent length (mm)	41.30	2.48	37.00– 47.00	37.30	2.64	31.00– 45.00
Dominant frequency (kHz)	1.86	0.20	1.70– 2.30	1.93	0.19	1.60– 2.20
Pulse rate (p/s)	118.10	17.66	83.00–156.00	98.70	12.30	77.50–123.30
Call duration (s)	0.18	0.03	0.13– 0.24	0.17	0.02	0.12– 0.22

For analysis of variation in advertisement call parameters in relation to size, snout-vent length was measured to the nearest millimeter with a plastic rule. Product-moment correlations between male snout-vent length and each of the call variables were calculated.

Results and Discussion

A sufficient sample (N = 20) of calls for analysis was obtained only at Baker Lake on 21 July 1984. All calling males had body temperatures of 18 ± 1 C: hence, temperature-induced variation was considered negligible. Further, Renaud (1977) found no correlation between temperature and advertisement call variation in *H. wrightorum*. Variation in dominant frequency, pulse rate, and duration of advertisement calls of *H. wrightorum* from Baker Lake was within the range of variation

documented by Renaud (1977) for this species. Renaud (1977) also recorded calls of a population of *H. wrightorum* at Baker Lake (Table 1). There was no significant difference in mean frequency (t = 1.11, P > 0.05) or mean duration (t = 1.24, P > 0.05) of advertisement calls recorded by Renaud compared with those of the present study. However, there was a significant difference in mean pulse rate (t = 3.93, P < 0.001). Variation in pulse rate of anuran advertisement calls is typically attributed to variation in body temperature (e.g., Gerhardt 1982); hence, these results suggest that pulse rate may be influenced by body temperature, contrary to Renaud's (1977) assertion. Unfortunately, temperatures are unavailable for his Baker Lake recordings.

Only dominant frequency was significantly (r = −0.47, P < 0.04, N = 20) correlated with
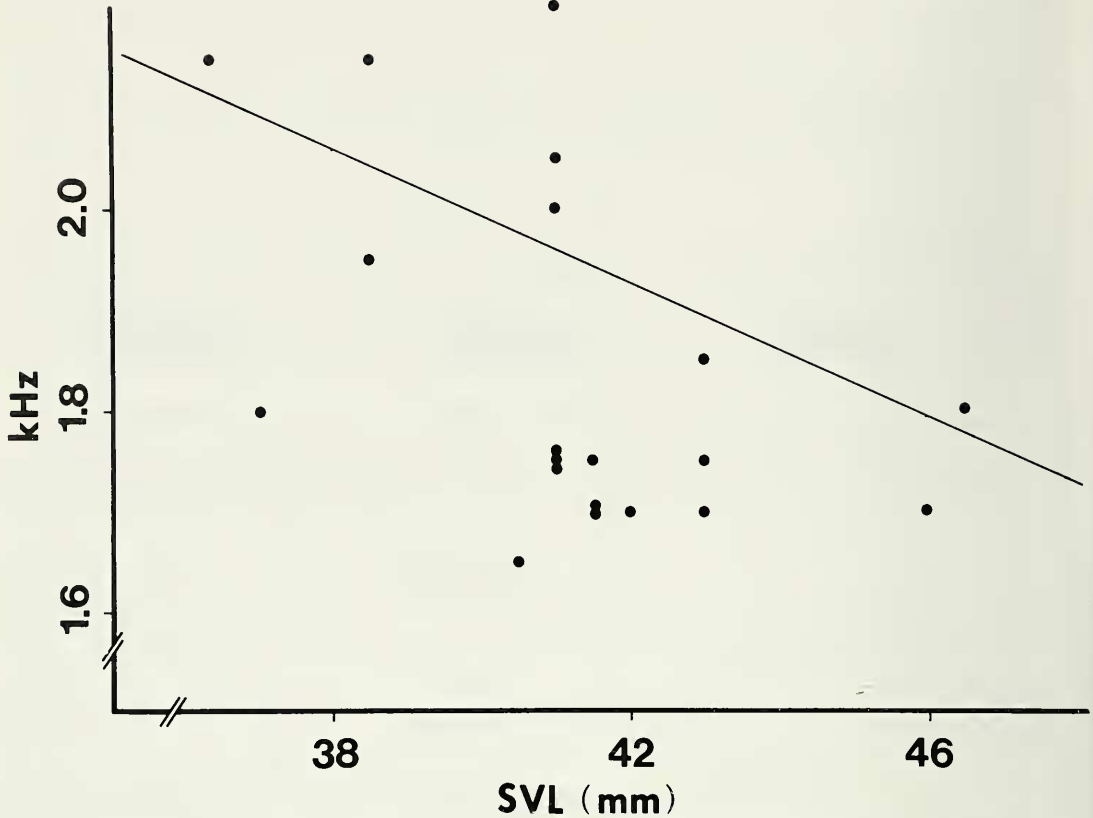
Fig. 2. Dominant frequency of advertisement calls against snout-vent length for 20 *Hyla wrightorum* from Baker Lake, Coconino County, Arizona. Body temperatures = 18 ± 1 C.

snout-vent length (Fig. 2). Neither pulse rate (r = −0.24, P = 0.29, N = 20) nor call duration (r = 0.12, P = 0.60, N = 19) were significantly correlated with male size. These results are consistent with a number of studies of anuran vocalizations and support the hypothesis that dominant frequency is determined by components of the vocal tract directly influenced by male body size (Martin 1972).

Many investigators of sexual selection in the Anura have documented a mating advantage for large males (see reviews by Kluge 1981, Gerhardt 1982). These workers have argued that females might select large mates on the basis of call parameters that are correlated with male snout-vent length. Such discrimination would be possible for *H. wrightorum* since advertisement call frequency is significantly correlated (negatively) with male size, presuming that females could detect small differences in frequency. However, males found in amplexus (x̄ = 40.6 mm snout-vent length) were not signifi- cantly (t = 0.96, P > 0.30, N = 30) larger than

nonmating males (x̄ = 41.3 mm). Further, there was no correlation between the sizes of males and females in amplexus (r = −0.04, P = 0.90, N = 10). Hence, mating success of males appears unrelated to size, as has been documented for a number of other hylids (Fellers 1979, Gatz 1981, Kluge 1981, Gerhardt 1982, Forester and Czarnowsky 1985).

My results, as well as the more substantial work of Renaud (1977), reveal that advertise- ment calls of *H. wrightorum* are distinct from *H. eximia*. Calls of *H. wrightorum* have a higher pulse rate and shorter duration than the majority of Mexican *H. eximia* (Duellman 1970). It is hoped that this brief report will foster a reassess- ment of the taxonomic status of this Arizona anuran.

ACKNOWLEDGMENTS

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